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Overlap Areas of a Square Box on a Square Mesh

by James U Cazamias

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REPORT DOCUMENTATION PAGE

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED (From - To)
April 2017	Technical Note	December 2016

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Overlap Areas of a Square Box on a Square Mesh	
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)	5d. PROJECT NUMBER
James U Cazamias	R.0023169.3.48
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
US Army Research Laboratory ATTN: RDRL-WMP-A Aberdeen Proving Ground, MD 21005-5069	ARL-TN-0818

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

To aid in a data-reduction process, an algorithm was generated to calculate on a square mesh (elements with sides of length 2m) the area of overlap for individual elements with a square box (sides of length 2n) that is not rotated relative to the mesh subject to the constraint n < 2m.

15. SUBJECT TERMS

data reduction, square mesh, overlapping squares, construction geometry, algorithm

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**	UU	10	James U Cazamias
Unclassified	Unclassified	Unclassified			**19b. TELEPHONE NUMBER (Include area code)** 410-278-9076

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1. Objective

To aid in a data-reduction process, an algorithm was generated to calculate on a square mesh (elements with sides of length 2m) the area of overlap for individual elements with a square box (sides of length 2n) that is not rotated relative to the mesh subject to the constraint $n < 2m$.

2. Algorithm

Ignoring edge elements, we can assume the following construction (Fig. 1) without loss of generality: 1) a 3×3 mesh with the coordinate system's origin at the center of the middle element and 2) a square box with center (x,y), which also lies in the middle element. The constraint ensures that the box lies entirely within the 3×3 mesh. We label the elements (i,j) with $i,j = 1,2,3$. We define the overlap area of an individual mesh element (i,j) with the box as A_{ij}. Since the box is not rotated relative to the mesh, notice that the overlap areas are rectangles with sides Δx_i and Δy_j with

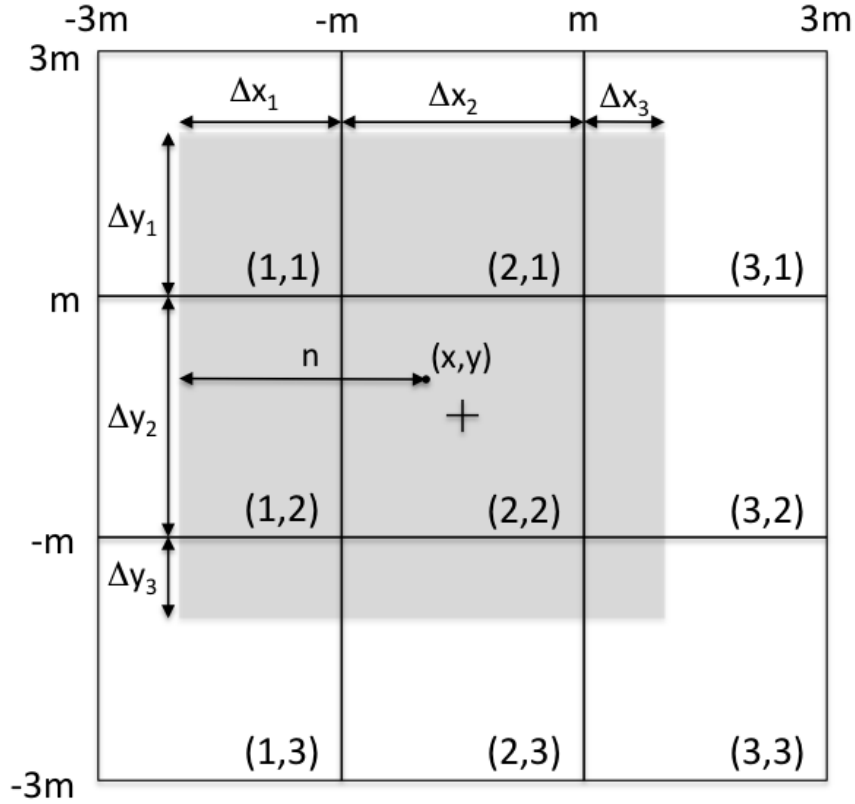$$A_{ij} = \Delta x_i \Delta y_j . \tag{1}$$

Fig. 1   Construction geometry

The terms Δx_2 and Δy_2 will always be nonzero, but we need to check if Δx_1, Δy_1, Δx_3, and Δy_3 are nonzero as well. The terms Δx_i and Δy_j are determined using Table 1 and Eqs. 2 and 3.

Table 1 Construction definitions

If	Then	Else
$x - n < -m$	$\Delta x_1 = n - x - m;\ x^- = -m$	$\Delta x_1 = 0;\ x^- = x - n$
$x + n > m$	$\Delta x_3 = n + x - m;\ x^+ = m$	$\Delta x_3 = 0;\ x^+ = x + n$
$y - n < -m$	$\Delta y_3 = n - y - m;\ y^- = -m$	$\Delta y_3 = 0;\ y^- = y - n$
$y + n > m$	$\Delta y_1 = n + y - m;\ y^+ = m$	$\Delta y_1 = 0;\ y^+ = y + n$

$$\Delta x_2 = x^+ - x^- . \tag{2}$$

$$\Delta y_2 = y^+ - y^- . \tag{3}$$

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